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IMPACT OF HORTICULTURE ON THE SUSTAINABLE LIVELIHOOD DEVELOPMENT OF SMALLHOLDERS: A SPAR-4-SLR & FUTURE RESEARCH AGENDA

Purpose. *The perishable nature of the horticulture (fruits, vegetables, and flowers) industry makes it more complex to study. The higher return and nutritional benefits compared to traditional agricultural products expand the research scope for the stakeholders' sustainable benefit. Nevertheless, despite limited research, this study explicitly examines additional facets of smallholder development beyond the traditional economic, social, and environmental dimensions.*

Methodology / approach. *To fill this knowledge gap, we comprehensively reviewed 73 articles published between 2013 and 2022 in international scientific journals with an SJR (Scimago Journal & Country Rank) Q1 ranking. We followed the "Scientific Procedures and Rationales for Systematic Literature Reviews" (SPAR-4-SLR) protocol to identify different aspects of smallholders' development. Literature from Web of Science and Scopus databases was analysed and organised using the TCCM (Theory, Context, Characteristics, and Methodology) framework.*

Results. *The study identified important factors like infrastructure, commercialisation, market access, marketing, credit, policies, information, intervention, training, technology, and collaboration that could uncover crucial economic, political, social, psychological, ecological, cultural, physical and nutritional aspects of development in general. The study also suggests that implementation Agriculture 4.0 through advanced technologies like IoT, AI, and vertical and bio-fortification practices can help in sustainable livelihood development in horticulture.*

Originality / scientific novelty. *The limited or lack of comprehensive studies on smallholders' sustainable livelihood development with different dimensions makes this research a bridge to identify other dimensions instead of only focusing on the horticultural sector's economic, social, and ecological aspects. It uses the Agricultural Innovation System and Farmer First theories, stating that the farmer is the first priority and must collaborate and interact to implement technology and innovations for smallholder livelihood development.*

Practical value / implications. *This research will help in decision-making regarding smallholders' livelihoods in all eight dimensions at all levels of government, private and other stakeholders, suggesting a triple-helix model.*

Key words: *economics, horticulture, sustainability, livelihood development, smallholders, technology forecasting.*

1. INTRODUCTION

Eight billion of the world's growing population (Worldometer, 2023) is moving toward demanding a more nutritious & healthy diet of fruits and vegetables instead of

consuming only staple grains (Pingali et al., 2019). The benefits of fruits and vegetables as part of a healthy diet are substantial for consumers and the food system in terms of increasing biodiversity, environmental sustainability, and enhancing farmers' livelihoods in the value chains (Joosten et al., 2015; López-González et al., 2021; FAO, 2020; WHO, 2019). In 2021, the production of fruits and vegetables reached 0.8 and 1.1 billion tons, respectively. The total commerce generated by these items amounted to 313 billion USD in 2021 and is projected to reach 545 billion USD by 2030 (FAO, 2022; Precedence Research, 2022). In 2019, the global trade in floricultural products amounted to 42.4 billion USD and is projected to rise to 57.4 billion USD by 2024 (Petal Republic Team, 2022). In addition, the revenue generated by horticultural products is significantly higher than that of staple grains. This led to a shift towards horticulture away from traditional agriculture as a means to reduce poverty (Weinberger & Lumpkin, 2007).

Horticulture has been shown to positively impact the long-term livelihood development of farmers (Galhena et al., 2013; Rai et al., 2019; Ulrich, 2014; Yasmin et al., 2014; Zhang et al., 2014). However, the inefficiency of SC in this sector makes it vulnerable to market access and farm-level pricing (Alam & Khatun, 2021; Middendorf et al., 2022; Sibomana et al., 2016), which annually loses 45 % of its total production (Shannon, 2021). The inefficiencies in horticultural SC are caused by a lack of training, policy, market for input and output, storage, information, standardisation and high intermediaries (Kumar, 2020).

Therefore, in this research, the authors attempted to conduct an SLR to assess the influence of horticulture (restricted to fruits, vegetables, and flowers) on the sustainable development (SD) of smallholder livelihoods, which focuses on increasing people's quality of life in social, economic and environmental aspects. It is found that to attain sustainable livelihood development (SLD), sustainable livelihood security is seen as a precondition. However, it is difficult to achieve SLD when individuals struggle to meet their basic needs due to a lack of resources and opportunities to establish a better life (Nath & Behera, 2011; Pani & Mishra, 2022). Firstly, this research addresses the dimensions of sustainable livelihood security (SLS) that result in SLD using the TCCM framework based on the SPAR-4 literature review protocol (Paul & Benito, 2018; Paul & Rosado-Serrano, 2019). There are arguments to be made as to whether social, economic and environmental security alone are sufficient to achieve the SDGs, or whether food, psychological, physical, political and cultural security need to be considered together for overall development. Secondly, the Agricultural Innovation System (AIS) (Francis et al., 2016; Lundvall, 2016; Rajalahti et al., 2008; Worldbank, 2007) and the Farmer First (FF) theories (Chambers et al., 1989) provide a theoretical perspective. They argue that the farmer is the first priority in the agricultural sector; the collaborative and interactive efforts between various stakeholders are necessary to implement different innovations in technology and practice (agriculture 4.0, technology forecasting & vertical farming) for the livelihood development of smallholders (Klerkx & Leeuwis, 2009). Lastly, future research direction has been proposed in the later section. A literature review on horticulture may assist smallholder

farmers in establishing sustainable livelihoods by identifying solutions to increase income, environmental sustainability, food security, market access, and climate change adaptation.

2. METHODOLOGY

This research uses a comprehensive literature review to assess the existing literature on horticulture (limited to fruits, vegetables & flowers only) impact on smallholder livelihood development across different dimensions. The SPAR-4-SLR protocol, combined with a TCCM framework-based review (Paul & Benito, 2018; Paul & Rosado-Serrano, 2019), was used to guarantee a rigorous and transparent literature review (Paul et al., 2021). Instead, protocols like PRISMA and PRISMAP are more descriptive, with limited possibility for theoretical development (Paul et al., 2021). There are six distinct phases (identification, acquisition, organisation, purification, evaluation, and reporting) within the broader three primary stages (assembling, organising, and evaluating) that make up the SPAR-4-SLR protocol (shown in Figure 1) (Paul et al., 2021).

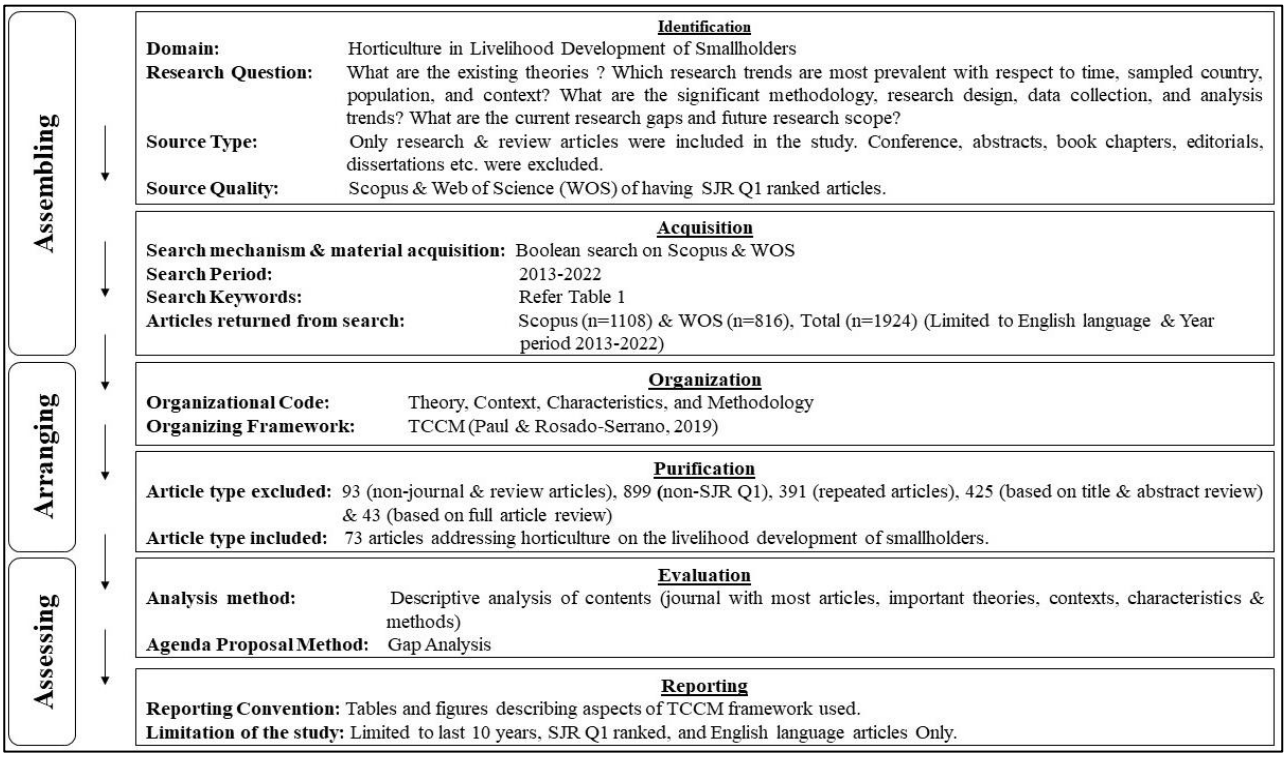

Figure 1. SPAR-4-SLR protocol for systematic review

Source: compiled by the authors based on Paul et al. (2021).

2.1. Assembling. In the first assembly stage, i.e., the "Identification" sub-group, Figure 1 comprehensively summarises the sources' scope, research questions, types, and quality. Only early access research and review articles from SJR Q1 ranked journals were included in the study, regarded as the best quartile journals (Lee et al., 2022; Memon et al., 2022; Stephen, 2020) indexed in Web of Science (WoS) and Scopus. Both databases' articles are widely acknowledged and used as high quality and interdisciplinary (Liu et al., 2014; Liu et al., 2012). The research did not include

abstracts, book chapters, editorials, dissertations, or other less mature publications (Enago, 2022; Levy & Ellis, 2006). In contrast, the acquisition step included the collection of scientific publications over the past ten years, published between 2013 and 2022, which used search terms and boolean operators (AND and OR), as shown in Table 1. The database searched articles for relevant keywords throughout their Title, Abstract, and Keyword sections. 1924 (WOS – 816 and Scopus – 1108) studies based only on English were extracted using research keywords.

Table 1

Key words used to search for data extraction from selected sources

Data source	Key word	Date & topic area
Scopus and Web of Science	["Horticulture AND Livelihood" OR "Livelihood AND Nutrition Garden"], ["Fruit OR Vegetable OR Flower" AND Livelihood"]	Date: 21.10.2022 Title, Abstract, and Keywords

Source: compiled by the authors.

2.2. Arranging. Arranging the literature through organising and purifying the materials is the 2nd stage of the SPAR-4-SLR protocol (Paul et al., 2021). The organisation of codes in this study was determined using the TCCM framework (Paul & Rosado-Serrano, 2019) on how horticulture affects smallholder livelihood development. The purification comprises a set of criteria for which articles are to be included and excluded. In exclusion criteria, 93 non-journal & review articles, 899 non-SJR Q1 ranked, 391 repeated studies, 425 based on title & abstract, & 43 based on full article review were excluded from the study. However, following a full-text review, 73 research and review articles comprised of conceptual/theoretical and empirical (qualitative or quantitative) studies addressing horticulture's impact on smallholder livelihood development were included in the study.

2.3. Assessing. Assessing includes evaluating and reporting on the reviewed literature in the last step of the SPAR-4-SLR protocol (Paul et al., 2021). The material contents were analysed and organised based on the TCCM framework, ensuring the reliability of the result. The results and discussion section adhere to Paul & Rosado Serrano's (2019) suggested TCCM framework in tables, graphs, overarching themes, and subthemes developed from the reviewed literature (Table 2–6, Appendix A and Figure 2). Future research direction has also been proposed based on the gap analysis in the reviewed literature. Furthermore, the findings' limitations and practical implications were discussed and addressed at the end of the study.

3. RESULTS

This section summarises the study's findings, including current theories, publishing patterns by year, sample country and journal, methodology used, contexts (product, sample, and security), and research study constructs.

3.1. Extant theories. This section includes all the theories considered and analysed in this review from 2013 to 2022. Table 2 summarises theoretical approaches based on their genesis and cited literature. The following theories were found in the

included studies and briefly discussed later in the discussion chapter: Theory of Change (ToC) (Gotor et al., 2018), Von Thünen's theory (Nigussie et al., 2019), Grounded theory (Cely-Santos & Lu, 2019; Rendón-Sandoval et al., 2021), Food systems theory (Harris et al., 2020), Utility maximisation theory (Habiyaremye et al., 2021), Profit frontier theory (Shrestha et al., 2022), and the Theory of consumers' and producers' economic surplus (Zhang et al., 2022).

Table 2

Existing theories highlighted in review and their origin

Theory used	Origin	Literature citation
Theory of change	(Bellon et al., 2015b; Bellon et al., 2015a)	(Gotor et al., 2018)
Von Thünen's theory	(Britannica, 2014)	(Nigussie et al., 2019)
Grounded theory	(Glaser and Strauss, 1967)	(Cely-Santos & Lu, 2019; Rendón-Sandoval et al., 2021)
Food systems theory	(Markram et al., 2013)	(Harris et al., 2020)
Utility maximisation theory	(Davis & Jensen, 1994)	(Habiyaremye et al., 2021)
Profit frontier Theory	(Kumbhakar et al., 2015)	(Shrestha et al., 2022)
Theory of consumers' & producers' economic surplus	(Marshall, 1890)	(Zhang et al., 2022)

Source: compiled by the authors.

3.2. Contexts. The study was conducted primarily within the framework of horticulture's impact on the development of smallholders' livelihoods, for which livelihood security (LS) is the precondition. LS encompasses food & nutritional (FNS), social (SS), economic (ES), physical (PS), psychological (PsS), ecological (EoS), cultural (CS) & political (PoS) aspects that are taken into consideration. The reviewed studies were in 43 journals published by 12 distinct publishers. Many such contexts, including geography, products, themes, samples, and research design, were discussed later in the discussion section (Table 3–5 and Appendix A).

The annual publishing patterns and publications in various journals are shown in Figure 2, covering the ten years between 2013 and 2022.

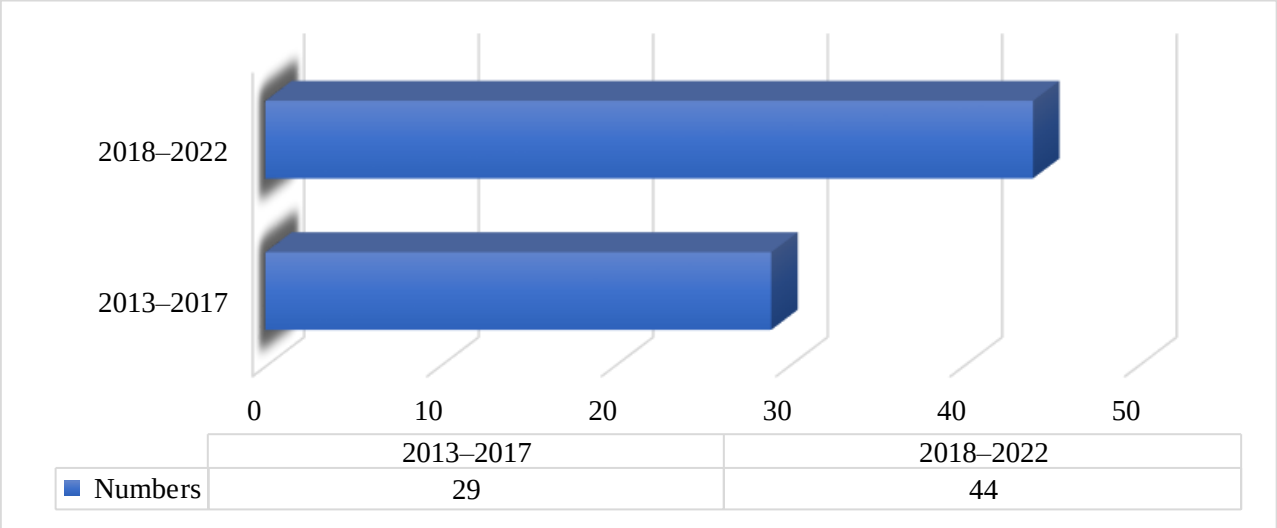

Figure 2. Published Q1 articles over the years

Source: compiled by the authors.

This research focused on studies between 2013 and 2022 because most of the research carried out in this domain gained pace during this period. The first five years, from 2013 to 2017, saw the publication of 29 papers, while the next five years, from 2018 to 2022, saw the publication of 44 research papers, representing an increase in the number of articles published.

Table 3 shows the number of articles published in various journals or publishers. The vast majority of the publications were published via a variety of publishing groups (15), including the majority of publishers like Elsevier (12), MDPI (5), and Springer (8). The preponderance of the publications was published across 43 different journals, with the majority appearing in Sustainability (9), Agroforestry System (5), Agriculture & Food Security (4), Food Security (4), and the Journal of Agricultural Sustainability (4). Publications related to agricultural science were primarily published to achieve sustainability in the horticultural sector, particularly for smallholders.

Table 3

Distribution of articles published across journals or publishers

Publishers	Source title	No of references	Percen-tage, %
1	2	3	4
BioMed Central Ltd.	Journal of Ethnobiology and Ethnomedicine	1	1.4
Cambridge University Press	Environmental Conservation	1	1.4
Czech Academy of Agricultural Sciences	Agricultural Economics	1	1.4
Elsevier	Agricultural Systems	2	2.7
	Agricultural Water Management	1	1.4
	Agriculture, Ecosystems & Environment	1	1.4
	Applied Geography	1	1.4
	Basic and Applied Ecology	1	1.4
	Chemosphere	1	1.4
	Ecological Economics	1	1.4
	Geoforum	1	1.4
	Global Environmental Change	1	1.4
	Heliyon	1	1.4
	Journal of Rural Studies	1	1.4
	World Development	1	1.4
Frontiers Media SA	Frontiers in Sustainable Food Systems	2	2.7
	Frontiers in Environmental Science	1	1.4
IOP Publishing Ltd.	Environmental Research Letters	1	1.4
MDPI	Agronomy	1	1.4
	Forests	3	4.1
	International Journal of Environmental Research and Public Health	1	1.4
	Sustainability	9	12.3
	Water	1	1.4
Nature Publishing Group	Scientific Reports	1	1.4
Oxford University Press	African Affairs	1	1.4
	Bioscience	1	1.4

Continuation of Table 3

1	2	3	4
Public Library of Science	PLoS One	1	1.4
Springer	Agricultural and Food Economics	1	1.4
	Agriculture and Food Security	4	5.5
	Agriculture and Human Values	1	1.4
	Agroforestry Systems	5	6.8
	Biodiversity and Conservation	1	1.4
	Environment, Development and Sustainability	3	4.1
	Food Security	4	5.5
	Human Ecology	1	1.4
Taylor & Francis	Agroecology and Sustainable Food Systems	1	1.4
	Biological Agriculture and Horticulture	1	1.4
	Journal of Peasant Studies	2	2.7
	International Journal of Agricultural Sustainability	4	5.5
The Resilience Alliance	Ecology and Society	1	1.4
University of Hawaii Press	Ethnobotany Research and Applications	2	2.7
Wiley	Development and Change	1	1.4
	Food and Energy Security	2	2.7
Total		73	100

Source: compiled by the authors.

As shown in Table 4, of the 73 studies analysed, 38 were country-specific, 3 were multi-country studies, and the remaining two were not country-specific. When authors state that their work is "not country-specific", it means that the ideas, theories or reviews being discussed are general. A closer look at the geographical location of the samples used in the studies revealed that the majority of studies were conducted in Asia (n=28), followed by Africa (n=24). Since the average income per person is so low, a large majority of horticulture research has been conducted to improve these low-income countries' economic performance and raise the living standards of their farmers (Rawat, 2020).

Table 4

Articles published across countries or regions

Countries			
Single Country (68)		Multiple Countries (3)	No Specific Country (2)
Region	Countries	Number of Publications	Status
1	2	3	4
Africa	Burkina Faso	1	Developing
	Ethiopia	3	
	Ghana	5	
	Kenya	5	
	Malawi	1	
	Nigeria	2	
	South Africa	1	
	Sudan	1	
	Tanzania	3	
	Uganda	1	
	Zimbabwe	1	

Continuation of Table 4

1	2	3	4
Asia	Bangladesh	1	Developing
	China	6	
	India	6	
	Indonesia	3	
	Iran	1	
	Laos	1	
	Myanmar	1	
	Nepal	5	
	Pakistan	3	
	Uzbekistan	1	
Australia	Australia	1	Developed
North America	Jamaica	1	Developing
	Mexico	1	
	Nicaragua	1	
	US	3	Developed
South America	Argentina	1	Developing
	Brazil	6	
	Colombia	2	

Source: compiled by the authors.

Of 73 papers, 64 were in developing countries, while only four were in rich countries. The maximum number of studies were carried out in India (n = 6), China (6), and Brazil (6), followed by Nepal (5), Kenya (5), and Ghana (5). This is because the sector is not as established as in wealthy nations. Due to the unfair price farmers receive for their produce, considerable research has been undertaken to develop the horticulture sector.

Over 95 % of the literature focuses on the economic aspect of farmers' or households' development in the horticulture sector, followed by social (44 %), psychological (35 %), food & nutritional (30 %), environmental (26 %), cultural (4 %), political (4 %) and physical (1 %) aspects of development, as shown in Appendix A.

3.3. Characteristics. The results of identifying the domain's most significant characteristics have been concentrated in this section. Based on the reviewed literature, the highlighted characteristics have been used as the antecedents or results of the impact of horticulture on life in many fields of knowledge (Ameen et al., 2022; Sharma et al., 2020) (Appendix A and Table 5).

Based on a review of 73 studies, Appendix A and Table 5 identify the following as the most significant antecedents of horticulture on farmers' livelihoods: infrastructure (12), commercialisation (7), market access (6), marketing (6), credit access (5), developmental policies (5), information (4), intervention (4), training (4), technology (4), and collaboration (4) discussed below in the discussion section.

3.4. Methods. This section presents many research methodologies used in the reviewed literature, summarised in Appendix A. A total of 69 research and four review articles were taken into consideration. In making our decision, the majority of empirical articles were taken into consideration, where quantitative research design (28) was

utilised in the majority of the studies, followed by the mixed method (19), the qualitative approach (17), and the experimental design (9).

Table 5

Antecedents & outcomes of study impacting smallholders' livelihoods

Antecedents	Sustainable livelihood outcomes	
Infrastructure Commercialisation Market Access Marketing Credit Access Policies Information Intervention Training Technology Collaboration Pandemic Diversification Motivation Intensification Producer Education Cropping Pattern Urbanisation & Globalisation Demand, Supply & Price Contract	**Economic:** Improved Yield Cost Minimisation Increased Income Employment Productivity Diversity Commercialisation Resource Utilisation Savings Risk & Uncertainty Agri-tourism	**Political:** Governance Empowerment Investment Subsidy & Incentives Policy & Schemes Credit Facility Training & Extension Infrastructure Dev. Market Access Land Reforms Efficient Value Chain
	Social: Social Interaction Collective Learning Information Access Good Recognition Coordination Collaboration	**Psychology:** Decision Making Skill & Knowledge Awareness Trust & Confidence Motivation Stress
	Ecology: Chemical Fertiliser Conservation Water Efficiency Soil Health Resilience Recycled Waste Input	**Culture:** Farming System Extension Service Traditional-Communication Food Preference Ceremony & Festival
	Physical: Self-life Working Condition Infrastructure Access (Input-based, Resource-based & Physical)	**Food & Nutrition:** Health & Alimentary Quality Food Availability Affordable Balance Diet

Source: compiled by the authors.

Out of the reviewed literature, in 43 studies, a survey method was used to conduct the research, 23 case study and 10 Focus Group Discussion (FGD) methods were used. Surveys and case studies were found to be very common in conducting investigations for qualitative and quantitative interpretation. In contrast, FGD used many cases where the problems need to be identified and given solutions in their natural setting (Ghanbari et al., 2022; Pachiyappan et al., 2022).

4. DISCUSSION

The discussion section helps interpret the results, analyse their significance in the

context of existing research, answer research questions, highlight research gaps, and potentially propose directions for future research.

4.1. Extant theories. The theory of change describes how an intervention is predicted to influence development. Change requires in-depth analysis, stakeholder engagement and multi-sectoral learning. A theory of change helps to find ways to effectively handle issues or risks that impede development and guide choices on achieving the desired change (Bellon et al., 2015a, 2015b; UNDG, 2017). The complex horticultural industry, susceptible to smallholders, also requires improvements. Therefore, government, private, technology, collaboration, or learning must intervene to change the sector (Adebiyi et al., 2021; Chikulo et al., 2020; Deka et al., 2020; Nigussie et al., 2019; Shrestha et al., 2022). The theory of change suggests a way to close the gap between research and practical application by aligning research with the priorities and urgency of these beneficiaries. The new agricultural knowledge can address their needs and offer sustainable benefits (Gotor et al., 2018; Thornton et al., 2017). This approach ensures that research is not conducted in isolation, but focuses on what matters most to the farmers who will ultimately use the new knowledge. According to Von Thünen's theory, the intensity of cultivation and the agricultural structure of production of a particular crop decrease with distance from the market. Thünen postulated that differences in transportation costs might explain the diverse land usage patterns. However, farmers don't often cultivate their products near the location of the market and are dependent on various transportation modes to reach the market (Britannica, 2014; Nigussie et al., 2019). While the horticulture industry is expanding, the return on investment for farmers with low bargaining power is meagre compared to other sectors, which reduces their satisfaction (Davis & Jensen, 1994; Habiyaremye et al., 2021; Sanga et al., 2021). If the firm's resources are managed well, according to the profit frontier theory, producers are seen as those who can most effectively maximise profits (Gichuki et al., 2019; Shrestha et al., 2022).

This argument is based on the theory of economic surplus of consumers and producers, which assumes that producers (farmers) and consumers want to maximise the benefits of their activities. However, the presence of intermediaries or lack of intervention makes it very vulnerable to both stakeholders. All the theories (Table 2) and most of the studies emphasise and suggest the SD of farmers in food & nutritional (FNS), social (SS), economic (ES), physical (PS), psychological (PsS), ecological (EoS), cultural (CS) & political (PoS) security aspects, which is impossible without any intervention.

4.2. Contexts. This industry is now more intriguing than it was in the past as a result of diversification away from conventional practice and the intervention of technology. The upward trend in quality articles may be shown more clearly in Figure 2 if we look at a series of time intervals spanning five years, beginning with 2013–2017 and continuing through 2018–2022.

After a comprehensive manual review of all the studies, it was discovered that most of them had drawn samples from households and farmers. In horticulture, fewer studies have been conducted on women, professionals, or government personnel,

revealing smallholder with other stakeholder gaps for entire sector growth. Different fruits & vegetables were given maximum importance in most reviewed studies, whereas minimum articles focused on flowers (Adam et al., 2013; Chauhan et al., 2021; Pachiyappan et al., 2022; Ulrich, 2014), as mentioned in (Appendix A).

4.3. Characteristics (Antecedents & outcomes).

4.3.1. Infrastructure, policy, horticulture & SLD. Developing infrastructure in the horticulture industry is possible through the market and institutional settings, which must be based on a market economy rather than a planned economy. These settings built connections between production and consumption and the flow of money, information, and goods (Zhang et al., 2014). The expansion of the region's supply chain for the horticulture sector is said to be facilitated by the construction of roads and technological advancements (Ulrich, 2014). According to Gilioli et al. (2015), developing social infrastructure that fosters stakeholder trust is just as important as developing physical infrastructure. Both types of infrastructure need to be developed; otherwise, the overall quality might be negatively impacted. Investments in infrastructure for processing, storage, and marketing will improve producers' ability to maintain their standard of living (Chikulo et al., 2020; Garrett et al., 2017). It is necessary to have input-based, resource-based, and physical infrastructure to reduce post-harvest losses and wastage, particularly in rural areas (Stratton et al., 2021). In most rural regions, fundamental rural infrastructure such as roads and access to transport services are essential variables impacting productivity and people's yearly income and vice versa. Transportation costs influence the whole supply chain of the horticulture industry, including the inputs, outputs, and market operations (Wudad et al., 2021). In addition, building market infrastructure (collection centres, cooperative markets, retail marketplaces, and road networks) requires significant government assistance to apportion resources and establish policies that guarantee farmers' access to market facilities (Pachiyappan et al., 2022; Shrestha et al., 2022). Islam et al., 2022 have given stressed cold chain infrastructure in the horticulture sector, which can significantly impact the livelihood development of smallholders in developing countries by increasing the product's shelf-life and return (Islam et al., 2022).

4.3.2. Commercialisation, horticulture & SLD. The commercialisation of the horticulture industry (must include home gardens) has significant economic effects on households by creating new job opportunities or opening up new markets (Park et al., 2019; Rendón-Sandoval et al., 2021). Opportunities to earn money or liquid assets give steady jobs for those with low levels of education and women, opening up possibilities for building wealth, securing access to housing, and financing children's academic development. Through out-grower programmes, the industry affects smallholder livelihoods by encouraging farmers to grow their food, improving farmers' access to inputs, markets, and price guarantees, cutting out intermediaries, and gaining access to extension services and technical advisors (Ulrich, 2014). Businesses, NGOs, cooperatives or FPOs may pool resources and expertise to help better use public utilities by linking up with government projects (Acheampong et al., 2018; Ball & Brancalion, 2016). Building health centres, classrooms, dams, and school sponsorships

are some ways commercial farms contribute to community development through corporate community outreach (Ulrich, 2014). The commercialisation of Uganda has shown promising results in boosting national income and employment and, ultimately, reducing poverty. For that, the government must promote the industry to expand its high economic value, demand and supply potential, extension, own processing facility centre, soft loans, training, more education and awareness on the health advantages, and catalysing full commercialisation (Barirega, 2014). Government policies and subsidies for agriculture should be enough to empower smallholders but not so restrictive that they limit competition (Park et al., 2019). The ideal scenario involves encouraging smallholders to actively participate and manage all stages of the agricultural value chain, maximising their potential for success. However, as the Baobab case study suggested, farmers were mostly impacted by lower product prices due to a lack of commercialisation or formalisation. The main factors influencing product prices are the presence or absence of preservatives, the clarity of product labels, and the sophistication of product packaging and certification (Darr et al., 2020).

4.3.3. Information, policy, market access, marketing, horticulture & SLD. Affordable credit, high-quality seeds and fertilisers, and efficient markets to sell their crops are ways policies can improve the well-being of farm families. This "two-pronged" approach reduces production costs (better inputs) and increases profit margins (better outputs), leading to more sustainable livelihoods (Chauhan et al., 2021; Darr et al., 2020; Nigussie et al., 2019). Most of the smallholders in Kenya rely on horticulture production for their livelihood as a source of income; however, substantial post-harvest losses due to a lack of easy and fast market access hinder its potential (Mujuka et al., 2020). Farmer-producer companies provide market access and sustainable livelihoods to small farmers by connecting them to bulk purchasers, according to an Indian case study. Market access may be gained through real-time information, financial assistance, government institutions, contracts for high-value items, and technical support (Deka et al., 2020; Lagneaux et al., 2021; Ngenoh et al., 2019). Perishability, labour intensiveness, and pandemics like COVID-19 reduce access to markets, resulting in less access to inputs that impact yields, revenue, transportation, and post-harvest loss in vegetable production and its supply chains. Policymakers and researchers need to work together to devise policies and measures to mitigate the effects of the continuing pandemic on agri-food systems and assist smallholder farmers in coping with the strain placed on them by a variety of distribution and retail outlets (Middendorf et al., 2022). However, processed products provide higher profitability, which allows companies to target niche markets or compete globally (Nigussie et al., 2019).

Effective marketing planning and periodic monitoring of organised/unorganised local vegetable farmer groups will protect against intermediaries (Rai et al., 2019). Awareness of production, regulations, and markets may assist in establishing resilient livelihoods and marketing beyond the local region (Chikulo et al., 2020; Ghanbari et al., 2022; Kousar et al., 2019). Improved information access related to the market helps farmers reduce losses throughout product storage, shipping, packing, and handling and

improves profit efficiency. Information services might be enhanced by encouraging private sector involvement in media, publishing, extension materials, training, and visit programme (Gupta et al., 2022; Shrestha et al., 2022).

4.3.4. Training, technology (Gardening, pollination, integrated & protective) collaboration, horticulture & SLD. Technological transfer to the broader population via greenhouses, boreholes, irrigation systems, better seed, agricultural loans, and training and extension services will assist developing nations in increasing vegetable production efficiency (Kousar et al., 2019; Shrestha et al., 2016; Ulrich, 2014). A case study of Ghana shows that the technology of growing vegetables in greenhouses using agronomic methods is a sustainable way to solve the problem and ensure year-round production of vegetables to increase yields and quality (Nkansah et al., 2021). Farming groups, cooperatives, and FPOs may also alleviate the technological limitation by sharing the most up-to-date technology among group members to make informed decisions (Adebiyi et al., 2020; Deka et al., 2020; Kousar et al., 2019). Another case study described the homestead garden concept, which households use to expand their conventional farming for economic benefit (Pritchard et al., 2019; Singh et al., 2016; Yasmin et al., 2014). The home garden will also help sustain situations like the Covid-19 pandemic (Alam & Khatun, 2021). Similarly, nanotechnology has gained popularity and helped farmers economically by improving output in terms of both quality and quantity. This is mostly attributable to the fact that it is more effective and beneficial than traditional agrochemicals (Salama et al., 2021). For direct and indirect socioeconomic and ecological benefits, scaling up more varied F&V systems will need integrated technology advances throughout supply chains (Stratton et al., 2021). New technology may be costly but yields a larger return (Shrestha et al., 2022). Meanwhile, bee-pollinated and protected farming techniques boost quality and profits while maintaining biodiversity and the environment with less labour. Yet, commercial pollination needs education, awareness and training to increase consumer surplus through product standardisation and certification. Both technologies would create employment and increase farm income, foreign exchange revenue, and effective use of scarce agricultural resources (Pachiyappan et al., 2022; Zhang et al., 2022).

Therefore, strengthening the horticulture SC to access markets, competitiveness, training facilities (technical & personal), technology and finance can only be resolved by collaboration between small producers and chain stakeholders (Ngenoh et al., 2019). Collaboration between government institutions, the private sector, NGOs, and local communities may be required to govern and manage agricultural development, social development, and biodiversity conservation (Adebiyi et al., 2021; Tang et al., 2013; Tanguay & Bernard, 2020).

4.3.5. Outcomes. Literature review results in the identification of key antecedents (Appendix A & Table 5) and outcome-based themes (economic, political, social, psychological, ecological, cultural, physical, food and nutritional factors) that, when taken together, lead to overall Famers' SD (Oerlemans & Assouline, 2004; Shwetha & Shivalingaiah, 2019). The sustainable growth of farmers necessitates a strategy that takes into account various facets of their means of livelihood as well as the environment

in which they function.

Economic development emphasises the expansion (Cely-Santos & Lu, 2019; Zhang et al., 2014) and diversification of agricultural operations (Djokoto et al., 2017; Galhena et al., 2013), facilitates market access (Deka et al., 2020; Shrestha et al., 2022), and promotes value addition and processing (Bariega, 2014; Chauhan et al., 2021; Gupta et al., 2022; Jayne et al., 2014). Alternatively, social security considers the needs and ambitions of farmer communities for promoting equality, inclusion, and social justice; provide access to healthcare and education; and encourage social cohesiveness and engagement (Balayar & Mazur, 2022; Bariega, 2014; Ngenoh et al., 2019; Stratton et al., 2021; Ulrich, 2014). In the area of physical security, infrastructure such as irrigation systems, soil conservation, and land-use planning contribute to sustainable agricultural development (Garrett et al., 2017; Graefe et al., 2013; Ulrich, 2014). Also, promoting pre and post-harvest infrastructure or technology and practices that preserve natural resources decreases greenhouse gas emissions and reduces climate change (Adebiyi et al., 2021; Kousar et al., 2019; Stratton et al., 2021). Psychological health and well-being, including mental health assistance, stress reduction, decision making and coping skills, are promoted via education, training, and awareness-raising initiatives (Middendorf et al., 2022; Nigussie et al., 2019; Yasmin et al., 2013, 2014). FNS is essential for sustainable farmer development (Cely-Santos & Lu, 2019). Farmers' SD demands an emphasis on cultural variety and preservation, including promoting traditional knowledge and practices and protecting cultural assets. This may be accomplished by policies and initiatives that encourage cultural diversity, the protection of cultural history, and acknowledging and valuing indigenous and local knowledge (Cely-Santos & Lu, 2019; Zhu et al., 2021). Excellent governance, decentralisation, and the development of participatory decision-making are required to promote environmental integrity and conservation and rehabilitate damaged ecosystems. Assuming the pre-requisite of SLS is met, then SLD can be ensured.

4.4. Methods. Women Open School (WOS) (2) & Workshop (2) were found to be very interesting methods in this area. Prior to the Women's Open School (WOS) approach, Pakistan's Farmer Field School (FFS) trains farmers to make informed decisions and become sustainable agricultural experts via hands-on training. This initiative has been used to push new pesticide use policies and promote non-chemical pest control approaches. The WOS model was effective, considering the country's cultural, ecological and socioeconomic growth. The initiative targeted rural women-led agricultural and home-based activities at the household level to rehabilitate and re-establish livelihood and capability for vegetable production. However, the programme cannot be carried out without the help of Facilitators & Trainers (Yasmin et al., 2013, 2014). Workshops are a useful tool for extension officers in agriculture because they allow a group of individuals to get together to ask questions, share information, identify issues, design a course of action, and execute the implemented plan. The workshop was held during the session on better using nutrients and managing manure for resilient agricultural systems, as stated in qualitative research in the United States and Mexico (Rendón-Sandoval et al., 2021; Stratton et al., 2021). Overall, WOS seems more

effective in implementing a plan based on practical training than other modes based only on a prior theory.

4.5. Research perspectives. The study has identified significant factors that can contribute to various aspects of SD, such as economic, social, ecological, psychological, physical, political, cultural, and food and nutritional factors. Based on the findings, the following implications can be drawn:

1. Increased supply chain capacity and output may be achieved by improvements to the horticulture industry's underlying infrastructure, mainly driven by market and institutional forces. Post-harvest losses and waste may be minimised through improvements to input-based, resource-based, and physical infrastructure in rural regions; improvements to roads, transportation services, and market facilities are crucial in determining income and productivity.

2. Job opportunities, increased household income, and improved educational chances are all direct results of commercialisation in horticulture.

3. Producers' households may save costs via improved access to data, policies, and markets and by selling processed goods rather than raw materials to penetrate new & large markets even through farmer-producer organisations.

The government, private sector, NGOs, and local communities must work together as AIS theory suggests to manage agricultural development and biodiversity conservation to maximise the environmental and economic benefits of agriculture 4.0, bee-pollinated, and vertical farming techniques. It also helps forecast technological requirements for the future.

4.6. Recommendations on research gaps in the reviewed literature and future research agenda. Proposed research gaps and future directions are derived from the findings and subsequent discussion. These proposals address the research question "What are the current gaps and future research scopes?" and are detailed in Table 6.

Table 6

Future research direction specific to TCCM framework

Thematic area	Identified research gaps
Theory development	Limited emphasis on sustainable livelihood development, agricultural innovation system, and farmer's first theories integrate economic, social, ecological, psychological, physical, political, cultural, and food and nutritional aspects of promoting long-term SD that benefits smallholders
Context	Found limited research on the geographic, extremal environment, power dynamics, and socio-political and psychological contexts in sustainable livelihoods
Characteristics (Antecedents)	Inadequate research on gender dynamics, climate resilience, market access, technology adoption, institutional policy and governance, and agroecological practices on smallholder horticulture livelihoods
Methodology	Limited study on longitudinal studies, participatory rural appraisal (Women open school), Interdisciplinarity, workshop, and Comparative Studies in horticulture for SLD

Source: developed by the authors.

SLD theory promotes a more holistic and integrated long-term development

strategy that benefits all stakeholders (Chambers & Conway, 1991; Shi et al., 2019) in the horticulture sector. A long-term vision is required that balances components to produce a more resilient, fair, and sustainable future for the people, communities, corporations, and government. It acknowledges that SD is a shared responsibility (Brand & De Bruijn, 1999) that needs cooperation across sectors, regions, and countries and promotes a higher quality of life for everyone while guaranteeing that future generations have the same opportunities and resources. Comprehensively, both AIS and FF theories contribute to promoting sustainable livelihoods for smallholders by emphasising the need for change through innovation, adaptation and contextual agricultural development. AIS provides a systematic approach that involves multiple stakeholders, while FF theory highlights the central focus on farmers for innovation. Both also emphasise a participatory approach that engages farmers in developing and adopting sustainable agricultural practices.

In geographic context, we usually discuss livelihood under favourable and monsoon climatic conditions (Williams et al., 2020), but how extreme environmental situations like drought and floods may affect livelihoods and how to eliminate them (Fadairo et al., 2020; Kousar et al., 2019; Steward, 2013). Power dynamics have also been studied in gender equality, indicating how women may struggle to acquire land and financing, affecting their livelihood capacity (Adebiyi et al., 2020; Balayar & Mazur, 2022; Habiyaremye et al., 2021). Socio-political factors, including political instability and inadequate institutions, may also hinder sustainable practices. Risk perception and societal norms may also influence SL methods. "Social farming or Care Farming" (Bassi et al., 2016) is another social aspect of development that refers to health, social, and educational benefits for vulnerable groups. Understanding the settings in which sustainable livelihoods are located is essential for establishing successful policies that consider the varied difficulties encountered by diverse groups.

Several developing countries rely on smallholder horticultural livelihoods for food security and poverty alleviation. Unfortunately, there is little study on the sustainability and resilience of smallholder horticultural livelihoods (Middendorf et al., 2022). Gender dynamics affect the ability to obtain resources, exercise decision-making power, and distribute benefits, contributing to their resilience (Reyes, 2017). Market access for fair pricing for smallholder horticultural livelihoods is also important (Shrestha et al., 2016, 2022). In addition, technological adoption, agroecological practises, and institutional policy and governance also need additional study to understand how policies and governance structures may promote the adoption of sustainable and resilient practices and boost productivity and livelihoods sustainably (Ball & Brancalion, 2016; Lagneaux et al., 2021; Rendón-Sandoval et al., 2021; Shrestha et al., 2022).

Research approaches that fully grasp complex relationships between elements are needed to enhance SLD in horticulture. Different research methods like mixed methodologies, longitudinal studies, participatory research techniques, multidisciplinary approaches, workshops, and comparative studies are needed to enhance SLD in horticulture. Limited research has been conducted on various vital

research methods, such as longitudinal studies, participatory rural appraisal (women open school), interdisciplinary approaches, workshops, and comparative studies (Ball & Brancalion, 2016; Stratton et al., 2021; Zhang et al., 2022). However, to understand the problem from scratch and make decisions, these methods may provide valuable insights into horticulture's SLD dynamics.

Therefore, SD, AIS, and FF theories are ideally suited to smallholder livelihood development (Chambers & Conway, 1991; Francis et al., 2016; Mapila et al., 2012). SD theory clearly addresses traditional livelihood development from the grassroots without much intervention. In contrast, AIS and FF theories based on responsible innovation emphasise that farmers should be prioritised first to enhance their livelihoods via the creation, diffusion, and adoption of new technologies and practices, which necessitates cooperation and interaction among agricultural system players (Rajalahti et al., 2008; Klerkx et al., 2012).

Agriculture 4.0 could be considered in technology innovations for data-driven decision-making and automation, including IoT, AI, and big data analytics, to improve agricultural efficiency, productivity, and sustainability (Navas et al., 2021; Rose et al., 2021). As a practice innovation, vertical farming uses hydroponics and aeroponics to grow crops vertically and could address issues of land scarcity, water scarcity, climate change, political land reforms, and high population growth (Marston, 2020; Umesh, 2022). The efficiency, production, resource utilisation and quality of crops in vertical farming can be enhanced with the implication of Agriculture 4.0 (Kucher, 2023), which holds immense potential to improve smallholder livelihoods (Javaid et al., 2022; Rose et al., 2021) across various dimensions:

1. Increased efficiency through precision farming leads to higher yields and potentially better market access, which means increased income and financial security (Javaid et al., 2022; Issaka, 2018).

2. Improved technology can help to shape policies that better meet the needs of small farmers and strengthen their bargaining power in the agricultural sector (Shiferaw et al., 2009; Jama & Pizarro, 2008) from a political viewpoint.

3. Access to information and digital platforms can foster stronger social connections among smallholders, facilitating knowledge sharing and collective action (Issaka, 2018; Andersson et al., 2012; Smidt & Jokonya, 2022).

4. Increased farm productivity and income stability due to technology can contribute to a sense of empowerment and improved mental well-being for smallholders (Javaid et al., 2022; Herath et al., 2021; Chen et al., 2023).

5. Data-driven practices can minimise water usage, optimise fertiliser application, and promote sustainable land management, all contributing to environmental health (Issaka, 2018; Linaza et al., 2021).

6. It can also document and preserve traditional agricultural practices (Achieng, 2023; Shareya et al., 2024), fostering cultural continuity.

7. Improved technology can guide crop selection and resource allocation towards more nutritious food production, improving smallholder families' diets and potential market offerings (Issaka, 2018; Abiri et al., 2023).

AIS also emphasises technology forecasting to anticipate new technology development and adoption, which drives agricultural innovation (Berg et al., 2019; Wirth & Markard, 2011). Nevertheless, these technologies may be slower to adopt in developing countries due to limited access to technology, infrastructure, education and training, which may not be beneficial for every smallholder farmer. FPOs can be a game changer in accessing those facilities collectively in every practical sense for livelihood development.

5. CONCLUSIONS

The research emphasises the role of the horticultural sector on smallholder farmers' livelihood growth and security. The economic dimension undoubtedly plays a pivotal role in reflecting about 95 % of the literature focusing on economic considerations, highlighting the industry's significance as a key driver of financial well-being. However, the noticeable gaps in attention to other dimensions of development, such as social (44 %), psychological (35 %), food and nutritional (30 %), ecological (26 %), cultural (4 %), political (4 %), and physical (1 %) aspects, suggest the need for a more comprehensive and holistic approach to research and policy formulation. Addressing these gaps will not only improve our understanding of the multifaceted nature of horticulture, but also pave the way for more inclusive and sustainable policies that promote the comprehensive well-being and sustainable growth of smallholder farmers. Infrastructure, commercialisation, market access, marketing, credit access, developmental policies, market intelligence, intervention, training, technology, and collaboration can uncover crucial economic, social, ecological, psychological, physical, political, cultural, and food and nutritional aspects of sustainable development in horticulture. Farmers generate income, employment, access to education and infrastructure to decrease post-harvest losses and waste (cold chain) through commercialisation. Small farmers may gain market access and sustainable livelihoods via farmer-producer firms, while agriculture 4.0, bee-pollinated, and vertical farming can help developing countries boost vegetable production efficiency and quality. SLD, AIS, and FF theories have given a comprehensive perspective on livelihood development through interventions. As AIS theory suggested, stakeholder collaboration is essential to manage horticultural growth and biodiversity protection through technological innovation and forecasting. Sustainable horticulture helps achieve the SDG 2030 goals of eradicating poverty and hunger, providing healthy lifestyles and education, empowering women, economic development & resilient infrastructure, and sustainable consumption and production. The study suggests that smallholder farmers in developing countries may find multiple dimensions encouraging long-term stability interlaced coherently in the horticulture sector for a sustainable future.

6. LIMITATIONS AND FUTURE RESEARCH

The study is subject to certain limitations as it exclusively focused on Q1-ranked English language research papers sourced from the Scopus and Web of Science

databases within the timeframe of 2013 to 2023, as outlined in the SPAR-4-SLR protocol. This may present an opportunity for future researchers to gain valuable insights by incorporating research papers from different rankings, languages, and databases.

The findings provide a basis for further multidisciplinary study on the topic of smallholder farmers' sustainable livelihoods, including the potential of new technologies to enhance productivity and profitability, the impact of the cold chain, market access, and marketing on smallholder farmers' livelihoods, and the role of policies and regulations in promoting the horticulture industry. Also, research on technology forecasting, agriculture 4.0, and vertical farming might provide a new dimension to improving developing countries' smallholders' livelihoods.

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Appendix A

Study characteristics of reviewed articles: research design, antecedents, contexts, & themes

Authors	Research Methodology	Antecedents	Contexts		
			Products	Sample	Security
1	2	3	4	5	6
(Adam et al., 2013)	Mixed (Case study & Survey: Interview & Observation, n=283)	Diversification, Education, Product price, Market, Demand, & Infrastructure	Baobab flower, Ziziphus Spina-christi & Balanites aegyptiaca	Household & Trader	ES
(Galhena et al., 2013)	Qualitative	Gardening	F & V	-	FNS, SS, ES, PsS, CS & EoS
(Yasmin et al., 2013)	Experimental (Women open school (WOS) method & FGD: n=30)	Community-based collective learning	Vegetables	Rural women	FNS, PsS & ES
(Venter & Witkowski, 2013)	Mixed (Case study: Interview, n=60)	Commercialisation & Investment	Baobab fruit	Farmers	FNS, SS, ES & EoS
(Tang et al., 2013)	Mixed (Case study & Survey: Interview, n=84)	Infrastructure	Orchards	Household	ES & EoS
(Graefe et al., 2013)	Qualitative	Product quality	Peach palm	-	FNS, SS & ES
(Steward, 2013)	Qualitative (Case study: Interview & Observation, n=29)	Market integration, Specialisation, Urbanisation, Globalisation, Policies, Motivation, & Infrastructure	Acai fruits	Household & Farmers	FNS, PsS, SS & ES
(Zhang et al., 2014)	Quantitative (Survey, n=100)	Cropping pattern, market, & commercialisation	Banana	Resource person, Village head & Household	ES
(Yasmin et al., 2014)	Experimental (Women open school (WOS) method & FGD: n=42)	Gardening	Vegetables	Women	FNS, PsS & ES
(Selwyn, 2014)	Qualitative (Case study, n=13)	Export	Table grape	Firm owners & Labours	PoS & ES
(Morsello et al., 2014)	Quantitative (Case study & Survey: Interview, n=95)	Market access	Vegetable	Household	ES
(Barirega, 2014)	Mixed (Survey, n=120)	Promotion & Commercialisation	Gooseberry	Traders & Farmers	ES

Continuation of Appendix A

1	2	3	4	5	6
(Bacon et al., 2014)	Mixed (Survey & FGD: Observation & Interview, n=244)	Infrastructure, Intervention, & Credit access	Corn	Cooperative members	FNS, PsS, SS & ES
(Ulrich, 2014)	Qualitative (Case study: Interview, n=55)	Market access & Commercialisation	Flower, F & V	Experts, Households & Employees	SS, ES & EoS
(Karp et al., 2015)	Qualitative (Case study)	Farming practice & Compliance cost	Spinach	Farmers, Govt. & non-govt. officials	FNS, SS & EoS
(Gilioli et al., 2015)	Experimental (Facilitation process, n=5)	Resilience	Horticulture	Household	SS, ES, PsS & EoS
(Shrestha et al., 2016)	Quantitative (Survey: n= 502)	Training, Market access & policy	Vegetables	Farms	ES & PsS
(Suhardiman et al., 2016)	Mixed (Survey, n=80 & Sase study, FGD, n=20)	Intensification	Fruits & Vegetables	Farmers	SS & ES
(Singh et al., 2016)	Quantitative (Survey: n=16)	Gardening	Fruits & Vegetables	Family	FNS & ES
(Ball & Brancalion, 2016)	Qualitative (Case study: Interview, n=56)	Commercialisation	Palm & Jucara	Farmers	SS & ES
(Ojwang et al., 2016)	Experimental (n1=50, n2=25, n3=13 & n4=7)	Process & Quality	Pigeon Pea	Poachers, Leaders, Government & Researchers	FNS & ES
(Sibomana et al., 2016)	Qualitative	Supply chain	Tomato		ES
(Djokoto et al., 2017)	Quantitative (Survey, n=621)	Infrastructure & Education	Vegetables	Farmers	FNS, PsS, SS & ES
(Geslin et al., 2017)	Experimental (n1=37, n2=51)	Pollination	Apples & Pears	Apple & Pear Tree	ES
(Garrett et al., 2017)	Mixed (Case study & Survey, n=367)	Infrastructure	Horticulture	Household	SS, PsS & EoS
(Keding et al., 2017)	Mixed (Survey, interview, n=370)	Practices, Preferences & Attitudes	Fruit	Household	FNS, PsS & ES
(Nchanji et al., 2017)	Mixed (Case study & Survey: FGD, interview, n1=20, n2=143)	Commercialisation, Urbanisation & Intensification	Vegetables	Farmers	SS, ES, PsS & ES
(Guthman, 2017)	Qualitative (Case study, n1=74, n2=50)	Collaboration, Contract, Credit & Market access	Strawberry	Farmers, agents, Middlemen, Regulators & advisors	ES & PoS
(Dai et al., 2017)	Mixed (Case study & Survey: interview, n=352)	Intercropping	Fruit	Household	ES & PsS
(Acheampong et al., 2018)	Quantitative (Survey: Interview, n=328)	Intervention	Tomato, Onion, Pepper, Eggplant, Okra & Cabbage	Farmers	FNS, PsS & ES
(Gotor et al., 2018)	Quantitative (Survey: Interview, n=206)	Conservation	Fruit	Household	FNS, PsS & ES
(Ngenoh et al., 2019)	Quantitative (Survey: Interview, n=1232)	Competitiveness	Vegetables	Household	SS, ES & PsS

Continuation of Appendix A

1	2	3	4	5	6
(Nigussie et al., 2019)	Quantitative (Survey: Interview, n=200)	Education Received Training, Credit, Experience, & Participation	Apple	Experts, Agents & Farmers	FNS, EoS, PsS & ES
(Davis et al., 2019)	Quantitative (Survey: Interview, n=40)	Infrastructure & Marketing	Bananas, Oranges & Grapefruits	Farmers	SS & ES
(Juma et al., 2019)	Quantitative (Survey: Interview, n1= 275, n2= 231, n3=16)	Information & Marketing	Avocado	Farmers, Traders & Informants	ES
(Park et al., 2019)	Quantitative (Survey: Interview, n1=139, n2= 29)	Infrastructure & Finance	F & V	Household	SS, ES & EoS
(Cely-Santos & Lu, 2019)	Mixed (Case study & Survey: Interview, n1=320, n2=16)	Pollination	F & V	Household	SS, ES & EoS
(Pritchard et al., 2019)	Mixed (Case study & Survey: Interview, FGD, n1=3320, n2=120)	Gardening	F & V	Household	FNS, SS, & ES
(Rai et al., 2019)	Quantitative (Survey: Interview, n=140)	Vegetable Farming	Vegetables	Household	SS & ES
(Kousar et al., 2019)	Quantitative (Survey: Interview, n=200)	Affiliation, Training, Market & Infrastructure	Apricot	Farmers	SS & ES
(Assefa et al., 2019)	Experimental (n=28)	Drip irrigation	Garlic, Onion, Cabbage, Tomato, & Sweet potato	Farmers	ES
(Chikulo et al., 2020)	Qualitative (Case study: Interview, n1=43, n2=65)	Infrastructure, Market, & Collaboration	F & V	Farmers, Retailers, & Marketers	SS, ES & PoS
(Sawe et al., 2020)	Experimental (n=13)	Pollination	Watermelon	Farms	ES
(Williams et al., 2020)	Quantitative (Survey: Interview, n=400)	Information access, Climate variability, & infrastructure	F & V	Farmers	SS & ES
(Fadairo et al., 2020)	Quantitative (Survey: Interview, n=193)	Perception & Climate variability	Vegetables	Farmers	SS & ES
(Suwardi et al., 2020)	Quantitative (Survey: Interview, n=450)	Policy, Promotion & Marketing	Fruits	Household	FNS & ES
(Mujuka et al., 2020)	Quantitative (Survey: Interview, n=160)	Technology	Mango	Farmers	ES
(Harris et al., 2020)	Quantitative (Survey: Interview, n=480)	Covid-19 pandemic & Policy	Vegetables	Farmers	FNS
(Darr et al., 2020)	Mixed (Survey: Interview, n=141)	Packaging, Quality, Labelling, Standards, & Marketing	Baobab Fruit	Household	SS & ES
(Deka et al., 2020)	Mixed (Case study: Interview, n1=36, n2=6))	FPO Intervention	Vegetables	FPO heads & Institutional buyer	ES & PsS
(Tanguay & Bernard, 2020)	Qualitative (Case study: Interview, n=99)	Collaboration, Resilience & Preservation	Vegetables	Household	FNS, EoS & ES

Continuation of Appendix A

1	2	3	4	5	6
(Paudel et al., 2020)	Experimental (n=8)	Conservation & Integrated pest management	Tomato, Cucumber, Bitter Gourd, Cabbage, & Cauliflower	Farms	FNS & ES
(Adebiyi et al., 2020)	Qualitative (Case study: Interview, n1=15, n2=9)	Organic Farming	Vegetables	Farmers	SS, ES & PsS
(Nuthalapati et al., 2020)	Quantitative (Survey: Interview, n=795)	Farmgate price	Vegetables	Farmers	ES
(Habiyare-mye et al., 2021)	Quantitative (Survey: Interview, n=250)	Integrated Farming	Vegetable & Poultry	Household	FNS, PsS & ES
(Salama et al., 2021)	Qualitative	Nanotechnology	Vegetables		ES
(Adebiyi et al., 2021)	Qualitative (Case study: Interview & FGD, n=17)	Technology	Leafy Vegetables	Farmers	ES
(Stratton et al., 2021)	Qualitative (Workshop)	Innovations	Avocados, Leafy Greens, & Tomatoes	Experts	SS, ES & EoS
(Rendón-Sandoval et al., 2021)	Qualitative (Workshop)	Peasant's Motivation	Vegetable	Local People & Managers	SS, ES, PsS & EoS
(Nkansah et al., 2021)	Experimental (n=5)	Spacing & Topping agronomic practices	Tomato	Farms	FNS & ES
(Wudad et al., 2021)	Mixed (Survey: Interview, FGD, n=176)	Infrastructure	Vegetables	Household	PS, & ES
(Zhu et al., 2021)	Quantitative (Case study: Interview, n=60)	Gardening	Horticulture	Household	CS & EoS
(Alam & Khatun, 2021)	Mixed (Survey: Interview, n=120)	Covid-19 pandemic	Vegetables	Farmers	FNS & ES
(Chauhan et al., 2021)	Quantitative (Survey: n=240)	Collaboration, Capacity Building & Marketing	Burans Flower	Farmers	EoS & ES
(Lagneaux et al., 2021)	Quantitative (Survey: interview, n=240)	Commercialisation, Diversification & Infrastructure	Fruit	Farmers & Specialists	EoS, PsS & ES
(Li et al., 2021)	Quantitative (Survey: interview, n=1051)	Cost of Production Insurance	Fruit	Household	EoS, PsS & ES
(Balayar & Mazur, 2022)	Qualitative (Interview, FGD, n1=16, n2=17, n3=6)	Commercialisation	Vegetables	Women Farmer	SS, PsS & CS
(Middendorf et al., 2022)	Quantitative (Survey, n=605)	Covid-19 pandemic	Cabbage, Onions, Eggplant, Tomatoes, Leafy greens, Garlic, Carrots, & Potatoes	Farmers	SS & ES
(Ghanbari et al., 2022)	Mixed (Survey, FGD: Interview, discussion, n1=96, n2=37, n3=2)	Policy, Process, Marketing, Technology, Awareness, Finance, Information, & Training	Fruits	Household	SS, ES & PsS

Ending of Appendix A

1	2	3	4	5	6
(Shrestha et al., 2022)	Quantitative (Survey, n=325)	Technical, Allocative, & Scale efficiencies	Vegetables	Household	FNS & ES
(Gupta et al., 2022)	Mixed (Case study, n=27)	Diversification	Vegetables	Farmers	SS, ES, PsS & EoS
(Zhang et al., 2022)	Quantitative (Survey, n=224)	Pollination	Kiwifruit	Farmers	EoS, PsS & ES
(Pachiyappan et al., 2022)	Mixed (Survey, FGD, n1=200, n2=12)	Protected Cultivation	Flower, F & V	Farmers	SS & ES

Source: compiled by the authors.

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